

Adventitious Root Production and Survival of Purple Loosestrife (*Lythrum salicaria*) Shoot Sections¹

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ABSTRACT. Purple loosestrife, *Lythrum salicaria*, notorious for successful wetland invasions, is a target of control measures including methods which produce shoot fragments. We document rejuvenation of purple loosestrife shoot sections and discuss the potential for vegetative reproduction through these fragments. Cut shoots (5, 10, and 15 cm long) were maintained in a greenhouse for four weeks. Approximately 80% of the shoots survived with production of adventitious roots and lateral shoots. Quantitative production of root biomass and lateral shoots was dependent on shoot length. Survival was not dependent on shoot length. Survival was greater among plants from drier habitats (100%) than from wetter soils (53%) and could not be predicted by pigmentation changes or necrosis. From a management perspective, fragment removal must follow mechanical eradication attempts in order to eliminate these vegetative propagules and prevent incidental recolonization.

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INTRODUCTION

Purple loosestrife, *Lythrum salicaria* L., is a non-indigenous wetland plant which invaded North America in the early 1800s (Stuckey 1980). It is well-established in the United States and Canada with serious infestations in the Great Lakes and St. Lawrence regions (Mal et al. 1992, Thompson et al. 1987). Its success in Ohio is clearly documented (Balogh and Bookhout 1989, Cooperrider 1995). Purple loosestrife is a perennial herb with a persistent tap root and produces several branching stems, each of which ends in a terminal spike of purple flowers (Cooperrider 1995, Mal et al. 1992).

This species is remarkable in its ability to invade wetlands and create virtual monocultures, thus, altering immense tracts of wetlands (Stuckey 1980). Although recently challenged by Anderson (1995), it is generally believed that these stands provide little habitat or food for the wildlife normally associated with the wetlands (Blossey et al. 1994, Mal et al. 1992, Rawinski and Malecki 1984). Consequently, management of purple loosestrife is a high priority among those concerned with preservation of these areas and their indigenous species (e.g., Welling and Becker 1992).

Many studies of purple loosestrife center on its formidable sexual reproduction capabilities. For example, a mature plant produces approximately three million seeds annually (Thompson et al. 1987). Sexual reproduction clearly contributes significantly to the competitive success of this species especially through seed bank recruitment (Welling and Becker 1993). There is, however, little quantitative information regarding purple loosestrife vegetative reproduction aside from shoot production by its perennating rootstock (Mal et al. 1992, Malecki and Rawinski 1985, Smith 1964).

Attempts to control large stands of purple loosestrife typically rely on herbicides (Gardner and Grue 1996,

Thompson et al. 1987); biological control may eventually provide the most significant long-term impact (Blossey 1995, Blossey et al. 1994). Initial attempts to eliminate early infestations or isolated plants of purple loosestrife, however, often rely on mechanical methods such as mowers, trimmers, hand clippers, or pulling individual plants by hand.

Each of these methods for mechanical eradication of purple loosestrife typically generates a litter containing shoot sections of various lengths. The fate of these sections, if left behind, is not clear. In this study we asked the questions: do shoot sections remain viable and, if so, are they capable of further growth? We also examined the effect of habitat history and section length on survivorship.

MATERIALS AND METHODS

In August 1994, entire purple loosestrife plants were harvested from three habitats: 1) an upland old field in the Cuyahoga Valley National Recreation Area in northeastern Ohio (n = 5); 2) a shallow ditch along Route 261 in Kent, OH (n = 10); and 3) the western shoreline of East Twin Lake, Portage County, OH (n = 6). These sites represent habitats which are never inundated with water, are periodically inundated, or have saturated soils, respectively.

Shoot sections of 5, 10, and 15 cm lengths were cut from these plants and positioned in flats containing a soil mixture of perlite, vermiculite, and peatmoss (1:1:1). The flats were maintained in the Department of Biological Sciences' greenhouse where they experienced ambient meteorological conditions except for 6 sec of mist every 3.5 min between 0800 and 2000 h daily. Shoot sections and attached leaves were examined at weekly intervals for pigment and tissue changes as well as for development of lateral shoots. After 26-28 days the sections were rinsed to remove adherent material and dried at room temperature (approximately 22° C) for a week. The adventitious roots from each section were removed with needle-nose forceps, dried at 60° C

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for 24 h, and then weighed to determine dry biomass. One Lake site 5-cm section was lost during processing.

Our working definition of shoot section death was the inability to produce adventitious roots because without these roots further nutrient uptake, hence growth, becomes negligible. Analysis of Variance (ANOVA) and other statistical tests followed Sokol and Rohlf (1981).

RESULTS

Of 62 shoot sections, 52% ($n = 32$) exhibited pigment/necrotic changes and 19% ($n = 12$) died (Table 1). These visual changes were not closely related to mortality: e.g., seven shoots died after developing some necrotic tissue, five became necrotic but did not die, and five died without necrosis. Shoot length also had little effect on survivorship with 19% mortality across all size classes (Table 1). Lake plants produced the fewest number of lateral shoots per section (0.36) while the drier habitats averaged about one per section (Table 1). Six of the 15 cm shoot sections (Upland-2; Ditch-1; Lake-3) also produced basal aerenchymatous tissue.

TABLE 1

*Relation of habitat and section length to the number of *L. salicaria* shoot sections producing lateral shoots (ls), losing chlorophyll and/or becoming necrotic (cn), and dying (dy).*

Habitat (n)*	5 cm			10 cm			15 cm			Total		
	ls	cn	dy	ls	cn	dy	ls	cn	dy	ls	cn	dy
Upland (5)	5	1	0	5	2	0	5	2	0	15	5	0
Ditch (10)	7	3	1	10	5	1	10	8	2	27	16	4
Lake (6)	2	3	3	3	4	3	3	4	2	8	11	8
Total	14	7	4	18	11	4	18	14	4	50	32	12

*n = number of plants from each habitat used in experiment.

All sections from the drier Upland habitat developed adventitious roots while 87% and 53% from the intermittently wet Ditch and perpetually wet Lake sites, respectively, also produced adventitious roots and survived (Table 1). Adventitious root dry biomass ranged from 0.8 to 155 mg for all shoot sections and had an overall mean (M) of 38.8 mg. Production of both root biomass and lateral shoots increased with section length (Fig. 1). Despite average coefficients of variation of 74% for root biomass and 57% for lateral shoot production, ANOVAs indicated significant size-class differences. Student-Newman-Keuls rankings ($P < 0.05$) showed 15 cm = 10 cm > 5 cm for both root biomass and shoot numbers. Ninety-six percent of surviving sections produced lateral shoots ($M = 2.6$ per section) while only 25% of the sections which eventually died produced these shoots ($M = 0.6$). These means were significantly different ($P < 0.001$). Root biomass was positively correlated with numbers of lateral shoots ($r = 0.491$, $n = 50$; $P < 0.01$).

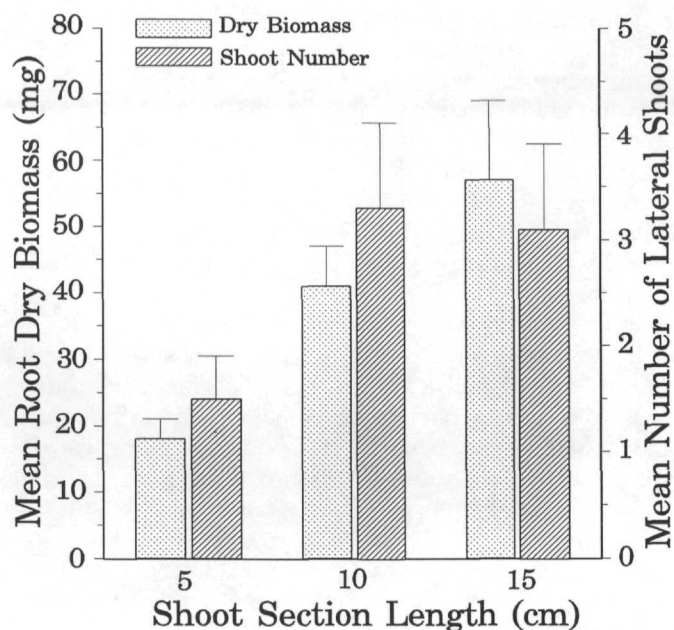


FIGURE 1. Relation of shoot length to production of adventitious root biomass and lateral shoot numbers. Bars are category means, and vertical lines depict ± 1 standard error.

DISCUSSION

Eradication of *L. salicaria* is a high priority among wetland managers because of areal losses to this species. No thorough eradication method currently exists. Inundation, chemical treatment, biological control, and physical removal of these plants all have limitations (Mal et al. 1992, Thompson et al. 1987). Current practice when harvesting the plants from an infested site does not emphasize careful removal of stem fragments from that site.

We found that shoot sections 5-15 cm long had equal chances for survival as about 8 out of 10 survived regardless of length. Shoot pigment changes and necrosis were not useful predictors of shoot section mortality in this study. Habitat-based survival differences, however, were evident. Shoots from the drier Upland site had 100% survival while the Lake site shoots were much less hardy in terms of survival and lateral shoot production. These differences may indicate genetic differences between stable ecotypes or seasonal physiological predisposition to the greenhouse conditions.

New tissues produced by the survivors included adventitious roots, lateral shoots, and aerenchyma in some instances. The quantitative production of adventitious root biomass and lateral shoot numbers was dependent on section length. These responses may be saturated around 10 cm as the increases between 5 and 10 cm were statistically significant, but the changes between 10 and 15 cm were not. Size-dependent responses, such as these, are expected since shoot section length determines the amount of stored nutrients and the amount of active photosynthetic tissue available for continued survival. The lower size limit for purple loosestrife shoot section survival is undocumented.

Our results show that cut purple loosestrife plants

produce viable shoot sections which are capable of growth and may serve as vegetative propagules. Development of new tissues is a clear sign of healthy, growing shoot sections and indicates that the sections could go on to produce mature plants if left undisturbed. Under our growth conditions, 80% of shoot sections could have matured into seed-producing plants. With this scenario the effort of purple loosestrife removal would be to no avail and might even exacerbate invasion problems.

In the natural setting where conditions are not likely to be as conducive to survival as presented here, even 10% survival of purple loosestrife shoot fragments translates into a step backward from eradication. Typical losses to herbivores, such as muskrats and rabbits, would not occur because these grazers avoid or ignore purple loosestrife stems even when cut (Shamsi and Whitehead 1974, Thompson et al. 1987). Removal of any size shoot fragment from a managed site is a necessary precaution against generation of vegetative propagules and the resultant recolonization.

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